

REMARKS

Upon entry of the above amendments, this application will contain claims 1-19 and 21, pending and under consideration. The application was originally filed with claims 1-20. Claim 20 was canceled in a Preliminary Amendment. In the present Response, new claim 21 has been added. Claims 1, 4, and 6-11 have been amended.

Amendments to the Specification

The written specification has been amended to insert section headings as provided by 37 CFR §1.77(b). Additionally an Abstract was added. It is believed that these amendments do not add any new matter.

Drawing Objections

The drawings were objected for failing to show the first polarization rotation element (b) and a polarization selection element (d). The applicants respectfully traverse this objection. The first polarization rotation element is any of the 4, 5, 6, or 7 mirrors shown in the figure. “[T]he first polarization rotation element may comprise one mirror of the cavity located such that the point of reflection of the beam is out of the plane defined by the points of reflection of three of the other mirrors.” (Application, page 4, lines 17-23, all citations to the present application refer to the published PCT application, WO 01/08274)

The polarization selection element is illustrated as the Faraday rotator 2. (Application, page 4, lines 24-25.)

Consequently it is believed that the figure does show all the claimed features. Therefore, withdrawal of the objection is requested.

Drawing Amendments

The figure has been amended as shown in the attached Replacement Sheet and on the Annotated Marked-up Drawing. Specifically semiconductor device 8 is added. Support for the added element can be found in the Application on page 5 line 30 through page 6, line 7. Therefore it is believed that this amendment does not add any new matter.

Rejections Under 35 USC §112

Claims 4, 6-8, and 10 were rejected under §112, second paragraph. Specifically, claim 4 was rejected for lack of antecedent basis for the term “the plane”. Claim 4 has been amended to recite that the “reflection of the beam is out of a plane defined by the points of reflection of three of the other mirrors.” It is believed that this amendment overcomes the rejection, and therefore, withdrawal of the rejection is requested.

Claims 6-8 were rejected for failing to define the angles of the mirrors with respect to the other components. Claim 6 has been amended to recite that the mirror is arranged to reflect light at an angle of reflection greater than 25 degrees from the normal of that mirror. It is believed that this amendment overcomes the rejection of claim 6 and that of claims 7 and 8, which depend from claim 6. Withdrawal of the rejection is requested.

Similarly claims 10 and 11 were rejected for failing to define their angles of reflection. Claims 10 and 11 have been amended to recite that the mirrors are “arranged to reflect light at less than 8 (or 4) degrees from the normal of said mirror”. It is believed that these amendments overcome the rejections.

In light of the above amendments and remarks, withdrawal of all rejections under §112 is requested.

Rejections Under 35 USC §102

Claims 1-11 and 18-19 were rejected under §102(b) over Johnston, et al. (US 4,272,158, “Johnston”). Claim 1 has been amended to more clearly define what the Applicants consider as their invention. Specifically claim 1 has been amended to recite that the “polarisation selection element comprises at least one mirror of the cavity spaced away from the gain medium and arranged to reflect light at an angle displaced from the normal of the at least one mirror such that the reflectivity of the at least one mirror is sufficiently polarization dependent that the laser oscillates uni-directionally”.

Briefly, the present invention is directed to a monolithic ring laser cavity. Light enters the illustrated system by gain medium (1), and then travels around the circuit in the shape of a figure of eight reflecting off four mirrors (4, 5, 6, and 7). The light on entering the system may travel around the circuit in two different directions (equivalent to clock-wise and counter clock-wise). This is undesirable. The present invention therefore provides a way of losing a greater

percentage of light traveling in the unwanted direction than that lost traveling in the wanted direction.

This is achieved by rotating the direction of polarization of the light in the circuit irrespective of the direction of travel of the light (by a first polarization rotation element) and rotating the direction of polarization of the light in the circuit with respect to the direction of travel (by second rotation element, e.g. Faraday rotator 2). The problem addressed by the invention is to remove light propagating in the unwanted direction, based upon the polarization of the light.

This is similar to the problem addressed by Johnson. However, in Johnson, a Brewster plate 32 is provided (which forms part of the "optical diode" 28. (Johnston, col. 4, lines 22-28.) The Brewster plate 32 acts to reflect a relatively high proportion of light traveling in the unwanted "backward" direction from the laser cavity e.g. see figure 2B, in which the unwanted light is indicated by the arrow 54. Light traveling in the preferred direction (as indicated in figure 2A) suffers zero reflection loss. (Id. col. 4, lines 37-38.)

In other words, Johnson describes a system in which a Brewster plate 32 is inserted into the cavity defined by the reflective mirrors 12, 14, 16, and 18. The Brewster plate acts to reflect a relatively high percentage of the light traveling in the unwanted direction, such that the ring laser oscillates in the preferred direction.

In direct contrast, the present invention does not require the addition of a separate component such as a Brewster plate. Instead, at least one of the mirrors of the laser cavity is used to act as a polarization selection element. In the embodiment illustrated in figure 1, two of the mirrors (mirrors 5 and 6) are used to act as the polarization selective element. These mirrors are arranged to reflect light at an angle displaced from the normal such that the reflectivity of the at least one mirror is sufficiently polarization dependant that the laser oscillates uni-directionally. A relatively high percentage of the light propagating in the unwanted direction is lost by transmission through the mirrors 6, 7. (Application, page 2, last paragraph.)

Thus, instead of requiring an additional polarization selection element (e.g. a Brewster plate 32 as utilized by Johnson), the present invention utilizes at least one of the mirrors of the cavity. Claim 1 has been amended so as to more clearly indicate that the at least one mirror is part of the laser cavity.

Johnston does not disclose a ring laser cavity that includes one of the mirrors arranged in the cavity to provide a polarization selection element as presently claimed. Therefore in light of

the above remarks, withdrawal of the rejections of independent claim 1 and of claims 2-11 and 18-19, which depend from claim 1 is requested.

Rejections Under 35 USC §103

Claims 12-17 were rejected under 103§(a) over Johnston in view of Dixon (US 5,289,491, "Dixon"). The Applicants respectfully traverse this rejection.

As discussed above, the present invention avoids the introduction of an extra polarization selection element, which would cause a decrease in performance of the cavity by using one of the mirrors, which is arranged in the cavity to function as a polarization selective element. The available prior art neither discloses nor indicates the combination of the technical features defined in claim 1. The available prior art discloses ring laser assemblies with extra polarization selective elements. Consequently, there is no motivation for the person skilled in the art to develop the invention from the prior art without exercising inventive step. In other words, the invention as presently defined by claim 1, is not only novel but also inventive over cited prior art.

Further, in a preferred embodiment of the present invention as illustrated in figure 1, it should be noted that the first polarization rotation element (arranged to rotate the polarization of light propagating in the cavity with a pre-determined handedness irrespective of the direction of propagation of light) is provided by one of the mirrors being located such that the point of reflection of the beam is out of the plane defined by the points of reflection by three of the other mirrors (the subject matter of claim 4). Thus, instead of utilizing an additional separate component to provide the first polarization rotation element (e.g. the equivalent of the polarization rotating element 48 of Johnson), the present invention utilizes a particular configuration of the mirrors defining the cavity to allow the number of components (and hence the potential sources of optical loss) within the cavity to be further reduced.

Dixon does not make up for the deficiencies of Johnston. Dixon also fails to disclose or suggest using a mirror arranged in the cavity to provide a polarization rotation element. In light of the above remarks, withdrawal of the rejections of claims 12-17 is requested.

The presently claimed invention operates to remove light traveling in the undesired direction in the cavity by using at least one of the mirrors arranged in the cavity as a polarization selection element. The prior art references use the Brewster plate to achieve a similar result. It

should be noted that omission of an element with retention of the element's function is an indicia on non-obviousness. (MPEP §2144.04.II.B.)

New Claim

New claim 21 has been added. Support for claim 21 can be found in the Application on page 8 last paragraph. Therefore it is believed that no new matter is introduced in this amendment.

Conclusion

In light of the above remarks, withdrawal of all rejections is requested. Applicants respectfully request timely reconsideration of this application leading to allowance of all pending claims. Additionally, the Examiner is invited to contact the undersigned attorney by telephone if there are any questions about this Response or other issues that may be resolved in that fashion.

Respectfully submitted,

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Annotated Marked-up Drawing

